

What is the role of minimally invasive surgery in a fast track hip and knee replacement pathway?

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ABSTRACT

INTRODUCTION Minimally invasive hip and knee replacement surgery (MIS) continues to receive coverage in both the popular press and scientific literature. The cited benefits include a smaller scar, less soft tissue trauma, faster recovery, reduced hospital stay, decreased blood loss and reduced post-operative pain. These outcomes are highly desirable and consistent with the aims of fast track hip and knee pathways. This paper evaluates the literature and discusses whether performing MIS over conventional surgical techniques offers advantages in a fast track hip and knee pathway.

METHODS An English language literature search was performed using the MEDLINE® and PubMed databases. Case series, randomised controlled trials and systematic reviews were included in the review.

RESULTS The reported improvements in recovery brought about by MIS must be considered multifactorial. In combination with improved clinical pathways, MIS can be associated with quicker recovery and shorter length of hospital stay.

CONCLUSIONS There is insufficient evidence to indicate that surgical technique alone makes a significant difference to recovery or reduces soft tissue trauma. No consensus on whether to use MIS techniques in fast track hip and knee replacement pathways can therefore be drawn. This is especially important given that the complication rates of MIS in the low to medium volume surgeon appear unacceptably high compared with standard approaches. It is also too early to assess the long-term effects of MIS on implant survival.

KEYWORDS

Minimally invasive surgery – Arthroplasty – Enhanced recovery

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A fast track surgical pathway (also known as a ‘rapid recovery’ or ‘enhanced recovery’ pathway) is a multimodal, team-based approach that accelerates patient recovery after surgery. The aim of the fast track approach is to optimise each individual clinical step of the peri-operative journey so that there is a shorter length of hospital stay, decreased morbidity and complications, an improved patient experience and a subsequent economic saving to the health system.

The concept of fast track surgical pathways originated in elective colonic surgery and the use of minimally invasive laparoscopic surgical techniques was central to the development of fast track pathways in this area. However, while fast track surgery pathways are being more widely adopted for hip and knee replacement patients, the importance of using minimally invasive surgery (MIS) in these pathways has not been discussed previously. This paper will therefore examine whether the use of an MIS technique should be a required element of a fast track hip and knee replacement pathway.

Methods

An English literature search was performed of the MEDLINE® and PubMed databases using the keywords ‘minimally inva-

sive surgery’, ‘mini-incision’, ‘hip arthroplasty’, ‘knee arthroplasty’, ‘fast track’, ‘rapid recovery’ and ‘enhanced recovery’. Case series, randomised controlled trials and systematic reviews were incorporated into this review.

History and evolution

The initial driving force behind minimally invasive joint surgery was cosmesis, reducing the length of the scar to less than 10–12cm for hips and less than 14cm for knees.¹ As with most new technology, there is the initial unbridled enthusiasm, then critical appraisal followed by a refining or discarding of the process. This holds true for MIS.

Minimally invasive total hip replacement (MTHR) surgery has been around for 30 years. Various approaches have been described but they are essentially modifications of the standard posterior, lateral, anterolateral or anterior approaches. Some of the first advocates were Light and Keggi, who used a direct anterior approach via a curved transverse skin incision.² Over three years they reported on a series of 104 patients. They described reductions in blood loss, improved levels of comfort, faster recovery and shorter hospital stays. These improvements were thought to be partly due to the preservation of the hip abductors.

The anterior incision continued to reduce in size over the years and in the last decade there have been encouraging reports of good outcomes including reduced dislocation rates, favourable component positioning and restoration of leg lengths.^{3,4} A special traction table is often required to improve visualisation for this approach.⁵

Bertin and Röttinger reported on a modified mini-incision anterolateral approach using the muscle interval between the abductors and tensor fascia lata.⁶ Again, with this approach there have been reports of reduced blood loss and length of hospital stay.⁷

The double incision approach is an adaptation of the posterior Moore and the anterior Smith-Petersen approaches.^{8,9} In 2004 Irving advocated the approach as limiting soft tissue trauma and facilitating faster rehabilitation.¹⁰ Berger pioneered a two-incision fluoroscopy assisted approach for total hip replacement.¹¹ Again, rapid recovery, 85% first-day discharges and a complication rate of only 1% were reported on the first 100 cases. It is worth noting that extensive cadaveric training had been undertaken along with careful patient selection. Furthermore, the definition of hospital discharge differs between countries.

Both the lateral (Hardinge) and posterior approaches have evolved to incorporate smaller incisions and subsequently less soft tissue trauma over the decades. There are variations on which precise muscles are released, including the piriformis, quadratus femoris and gluteus maximus. Many surgeons report favourable outcomes and early discharge using these techniques.^{12,15}

MIS of the knee evolved in the 1990s for unicompartmental replacement (UKR). An Oxford group led the way with improved instrumentation, making it possible to perform UKR through a small medial incision, thereby minimising soft tissue trauma and avoiding patellar dislocation.¹⁴ When comparing short and standard incisions, they showed that patients with a short incision met the discharge criteria twice as fast as the standard incision group. In 2005 they introduced an accelerated recovery protocol for UKR patients.¹⁵ The randomised controlled trial revealed significant enhancement in terms of early discharge and cost saving in favour of the accelerated recovery group.

These findings were confirmed by Borgwardt *et al* in a similarly designed randomised controlled trial four years later.¹⁶ However, both studies failed to show any significant difference in knee scores by six months after surgery. The accelerated programmes employed in the studies relied on improved anaesthetic and analgesia pathways, which probably had the greatest overall influence on early recovery. These MIS principles were applied to total knee replacement in an effort to enhance recovery by reducing quadriceps muscle strength loss, improving earlier return of function and reducing length of hospital stay.

Five minimally invasive approaches have been described for total knee replacement (MITKR). They are mini-medial parapatellar, quadriceps muscle sparing, mini-midvastus, mini-subvastus and direct lateral.

Following the initial interest in MIS, there was a flurry of encouraging surgeon reported case series.^{3,4,6,7,10-15,17,18} It became apparent that not only was the scar smaller but there

may also be potential benefits of a reduction in soft tissue trauma, shorter intra-operative time, less blood loss, less post-operative pain, faster rehabilitation and earlier hospital discharge. Over the next few years, study designs improved but it took a few more years for any level 1 evidence studies to emerge.

Recent times

Any early theories that scar size alone equates to early recovery in total hip or knee replacements have not been validated sufficiently by subsequent, better designed studies although some advocates still remain.¹⁹⁻²² The benefits associated with MIS are believed to be due to the multimodal nature of the MIS pathways. The earlier case series often involved careful patient selection and also pathways with fast track characteristics such as goal setting and more aggressive rehabilitation. These independent variables along with improved pain control have been shown to shorten recovery following UKR and hip replacement surgery.^{15,16,23-25} The MITKR techniques have been found in various studies and meta-analyses to result in significantly less pain in the first 24 hours after surgery when compared with standard knee approaches.²⁶ There is also a general trend towards lower blood loss.

Comparing minimally invasive techniques

The various types of MIS have spawned debate over which technique is the most advantageous in accelerating recovery. In 2010 Popischill *et al* investigated the effects of the MITHR lateral approach versus a traditional transgluteal approach on gait analysis.²⁷ No difference was identified. In 2006 Bennett *et al* verified similar gait kinematic findings²⁸ and in 2007 they showed no difference in immediate post-operative walking ability after MIS compared with standard incision hip replacement.²⁹ Ogonda *et al*²⁰ and Lawlor *et al*⁵⁰ published papers in 2005 showing no enhancement in early walking ability or functional outcome by six weeks when comparing an MIS posterior approach with a standard posterior approach. Interestingly, Pagnano *et al* reported a slower recovery in patients undergoing MIS in a well designed randomised clinical trial.³¹

In the knee, only two studies have critically examined early hospital discharge; the verdict was inconclusive on whether MIS alone is directly responsible for early discharge.^{32,35} As is consistent with the research on fast track surgery, it is proposed that early physiotherapy and improved anaesthesia probably play a more significant role.^{25,34,35}

The MITKR technique tends to allow significantly faster recovery times when it comes to regaining early range of motion. However, by the mid to long term, this initial advantage is lost compared with standard approaches. This is borne out by knee scores failing to show any difference between the two procedures.^{15,16,26}

Some surgeons have tried to compare the various MIS approaches in order to determine which is best. Leuchte *et al* compared the immediate post-operative advantages between an MIS Watson-Jones approach and an MIS posterior approach.³⁶ The posterior approach offered a significant advan-

tage in functional ability, symmetry indices of stance, loading rates and single limb stance in the first six weeks. However, by 15 weeks the results were the same. In a small study, the MIS Watson-Jones approach was favoured over the lateral transgluteal approach with regard to function, gait and Harris hip score at 6 and 12 weeks after surgery.³⁷ In 2004 a similar study by the same author comparing the MIS anterior approach with a standard transgluteal lateral approach only found short-term advantages of improved mobilisation, pain, gait and Harris hip scores at 5 and 10 days after surgery.⁵⁸ By six weeks any difference had normalised.

In 2009 Meneghini and Smits showed no difference between three MITHR approaches with regard to discharge, functional recovery or outcome scores over the first year.⁵⁹ An aggressive rapid rehabilitation protocol was used in all cases and most patients were reportedly discharged a day after surgery.

Goebel *et al* found only a temporary reduction in initial post-operative pain levels after an MIS anterior approach compared with a lateral approach.⁴⁰ There was also an improvement in time to attain range of movement and shorter hospital stay.

There are very few studies comparing two independent MITKR approaches. The randomised study by Bonutti *et al* compared the MIS subvastus and midvastus approaches in patients undergoing bilateral total knee replacement.⁴¹ They failed to demonstrate a difference. Aglietti *et al* compared the MIS quadriceps sparing and subvastus approaches in a randomised unilateral total knee replacement study.⁴² They reported earlier straight leg raising ability in the subvastus group but otherwise no other difference was demonstrated. Chin *et al* randomised patients into three groups comparing radiographic outcomes between the standard parapatellar, MIS midvastus and the direct lateral approaches.⁴³ The lateral approach had a higher likelihood of implant malalignment. Otherwise no difference was noted. More recently, Niki *et al* compared an MIS lateral subvastus approach for valgus knees with an MIS medial approach.⁴⁴ There was no clear difference except for lower visual analogue pain scores in the first week and lower myoglobin levels.

Soft tissue trauma

One of the rationales behind MIS is that a smaller incision and approach equates to less soft tissue trauma and therefore a faster recovery. General surgeons noted reductions in acute phase cytokines when comparing laparoscopic and open cholecystectomies.⁴⁵ A number of surgeons have tried to replicate this finding in minimally invasive arthroplasties. Various biochemical markers have been tested including C-reactive protein (CRP), creatinine kinase, myoglobin, aldolase, lactate dehydrogenase, glutamic oxaloacetic transaminase and creatinine. Wohlrab *et al* failed to demonstrate a difference in CRP levels when comparing an MIS Watson-Jones approach with a standard lateral transgluteal.³⁷ Similarly, Ogonda *et al* failed to demonstrate a difference in CRP levels when comparing MIS and standard posterior approaches to the hip.²⁰

Niki *et al* measured numerous biochemical markers in a study comparing MIS quadriceps sparing, subvastus, mid-

vastus and mini-parapatellar approaches with conventional subvastus, midvastus and parapatellar approaches.⁴⁶ The paper failed to show a difference between MIS and standard total knee replacements. However, it was noted that the midvastus approach, in both arms of study, created the greatest rise in myoglobin and creatinine kinase levels. It may be that the biochemical markers are too insensitive to distinguish between the surgical insult of arthroplasty and the smaller difference between approaches.

Failures

As with all new surgical techniques, MIS gained an enthusiastic following after the original case series were reported. Unfortunately, as is often the case early in a learning curve, the initial results could not be replicated in other surgeons' hands and a wave of complications were reported. These have included neurovascular injury, component malposition, dislocations, excessive skin trauma, compromised implant fixation and fracture as well as higher early revision rates in both hips and knees.^{16,26,58,47-49}

It is because of unacceptably high complication rates that the two-incision MITHR has generally fallen out of favour in all but the most experienced of hands. Most of the complications have been put down to the learning curve of a new approach, technique and inadequate visualisation. Many of the pioneering surgeons had practised the technique on cadavers prior to performing the approach on live patients. Some studies have failed to include the initial learning curve and should therefore be interpreted with caution.^{20,51}

Conclusions

MIS has driven the development and refinement of improved and less invasive surgical instrumentation. The introduction of MIS in hip and knee replacements has also been accompanied by improvements to clinical pathways and the adoption of fast track protocols. In addition to the MIS literature, accounts of fast track pathways using conventional surgical techniques have achieved similar reductions in length of hospital stay and speed of recovery. Therefore, at present, there are too many confounding factors to show convincingly that MIS in isolation results in accelerated recovery for patients compared with conventional surgery. Furthermore, MIS has failed to show, biochemically, any significant reduction in soft tissue trauma when compared with conventional arthroplasty.

Several issues therefore remain. MITHR and MITKR will always be popular with the media and certain patients. However, unlike general and endoscopic surgery, in isolation, there are few proven advantages of MIS over conventional arthroplasty, particularly in the hands of the low to medium volume surgeon. The exception appears to be UKR. The optimal incision size should consequently be dictated by a combination of patient habitus, surgeon experience and implant instrumentation. Only time and registry data will reveal whether implant longevity has been compromised by incision size.

While not being conclusive in helping us to decide

whether MIS is advantageous over conventional surgical techniques, the literature does confirm the value of fast track pathways in accelerating patient recovery. Optimised pre-operative preparation, anaesthesia, analgesia and rehabilitation are certainly aspects of the MIS pathways described in the literature that are here to stay.

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